§16. Effects of Static Magnetic Island on Resistive Interchange Mode in a Straight Heliotron Plasma

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The effects of the $(m, n) = (1, 1)$ static magnetic island due to the external magnetic field on the resistive interchange mode with the same mode number are studied[1]. For this purpose, we utilize the equilibria with the pressure profile consistent with the island geometry of which the gradient at the X-point is finite[2]. The equilibrium island width w_i is increased as the external poloidal magnetic flux at the plasma edge Ψ_b is increased. The relation between w_i and Ψ_b is shown in Fig.1. The linear stability and the nonlinear development are studied with the improved NORM code[3] which is based on the reduced MHD equations. At first, the linear stability is examined. The growth rate of the interchange mode is decreased with the increase of the equilibrium island width, as shown in Fig.2, in spite of the finite pressure gradient at the X-point. The mode is completely stabilized when the equilibrium island width exceeds a threshold value. The threshold width is almost the same as the half-width of the eigenfunction of the stream function obtained for the equilibrium without an island. This result seems to be consistent with the experimental results in LHD[4].

Next, the behavior of the mode and the island in the nonlinear saturation phase is analyzed. The saturation level of the kinetic energy is also decreased as the island width is increased as shown in Fig.3. On the other hand, the nonlinear evolution changes the width of the magnetic island as shown in Fig.1. If the phase of the equilibrium island is the same as that of the island generated by the interchange mode ($\sigma = +1$), the island width is increased. If the phase is opposite ($\sigma = -1$), the island width is decreased and the phase can also be changed. In the point of the relation with the flow generated by the mode, the island width increases when the flow direction is radially outward at the X-point of the equilibrium island and decrease when the flow direction is radially inward at the X-point. The interchange mode also changes the pressure profile through the convection. The tendency of the profile change is almost independent of the equilibrium island structure. The pressure is locally increased by the outward flow and decreased by the inward flow. The local flat structure at the O-point of the equilibrium island is almost kept even if the structure is changed to the X-point.

1) K. Saito, K. Ichiguchi and R. Ishizaki, submitted to Plasma Fusion Res.

2) K. Saito, K. Ichiguchi and R. Ishizaki, Plasma Fusion Res. **7**, 2403032 (2012) .

3) K. Ichiguchi, N. Nakajima, M. Wakatani, B. A. Carreras and V. E. Lynch, Nucl. Fusion, **43**, 1101 (2003).

4) H.Yamada, et al., Contrib. Plasma Phys., **50**, No.6-7, 480-486 (2010).

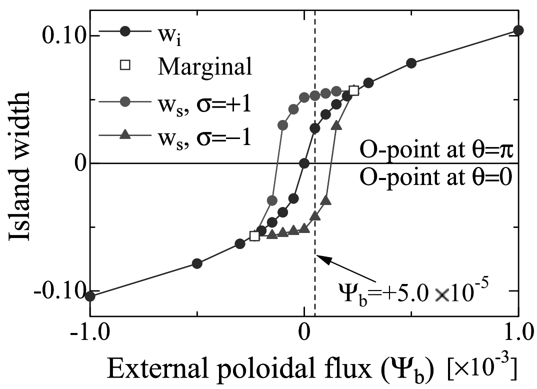

Fig.1 : Dependence of island width on Ψ_b. Positive and negative values correspond to the island with the O-point at $\theta = \pi$ and $\theta = 0$, respectively. Blue circles and squares show w_i and the threshold width for the marginal stability, respectively. Red circles and green triangles show the island width in the saturation of interchange modes, w_s, for $\sigma = +1$ and $\sigma = -1$, respectively.

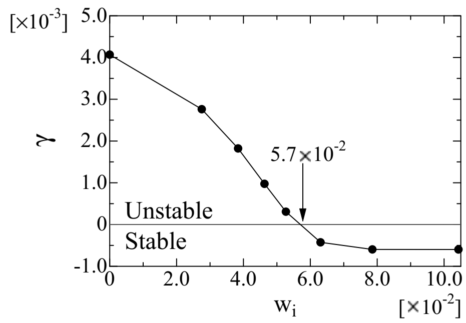

Fig.2 : Dependence of the growth rate of the interchange mode in the linear phase on w_i.

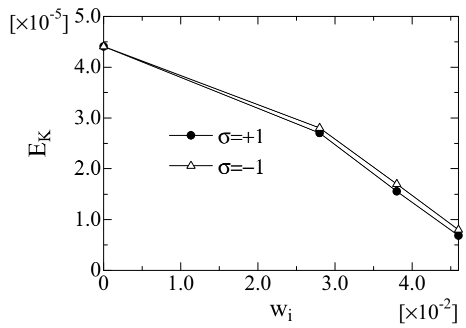

Fig.3 : Dependence of the kinetic energy on w_i in the steady state.